PATENT ABSTRACTS OF JAPAN

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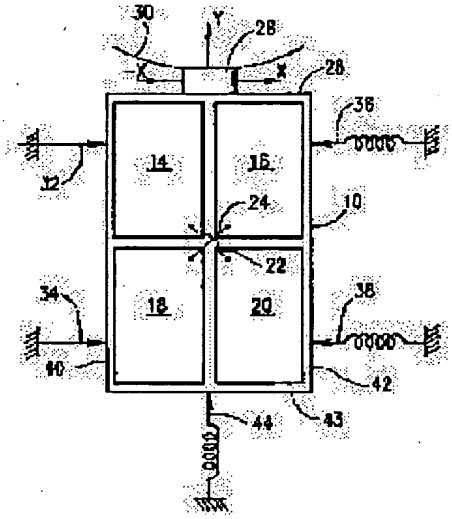
(54) MICROMOTOR

(57)Abstract:
PURPOSE: To obtain a high driving force by attaching a ceramic spacer to a short edge of a piezoelectric plate and providing an elastic force source for pressing the spacer to an object surface to a part of the plate.
CONSTITUTION: Electrodes 14, 16, 18, 20 are placed on a piezoelectric ceramic (SK) 10 surface. The opposite surface of the SK 10 is entirely covered and grounded. The electrodes (14 and 20, 16 and 18), arranged in the diagonal direction, are connected with wires 22, 24. A ceramic spacer 26 is mounted to the center of a short side 28 of SK10. The resonance mode is used, depending on Dx, Dy sizes of SK10. SK10 is restricted in its movement by supporting bodies 32, 34 and supporting bodies with springs 36, 38. The supporting bodies 32 to 38 are placed in contact with the SK10 along the longer sides 40, 42 at the position 0. These supporting bodies are designed to be slidable in a y-direction. The supporting body 44 with spring is pressed to the center of short side 43, giving a pressure between ceramic 26 and main body 30. Thereby, the movement of the ceramic 26 is transferred to the main body 30.



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CLAIMS

[Claim(s)]
[Claim 1] the following -- having -- the [of the 1st piezo-electricity plate] -- 1 short hand edge -- the [of the 2nd piezo-electricity plate] -- the piezo-electric micro motor which is characterized by being almost parallel to 1 short hand edge, and being close and which gives movement to a body the [the 1st and] -- the [2 straight-side edge, the 1st, and] -- the [the 1st which has the electrode connected to 2 short hand edge, the front face and the rear face, the front face of this, and the rear face, and] -- 2 piezo-electricity plate the -- the ceramic spacer which is attached in the 1st straight side edge and engaged on the surface of a body by the end near the 1 short hand edge The source of an elastic force which is impressed to some each plate and presses a ceramic spacer on the surface of a body. The voltage source which impresses excitation voltage to some electrodes at least.
[Claim 2] The aforementioned source of an elastic force is a micro motor according to claim 1 impressed to a part of 2nd straight side edge at least.
[Claim 3] The aforementioned source of an elastic force is a micro motor according to claim 1 whose movement amplitude perpendicular to the aforementioned field it is impressed by the point on a piezo-electric plate, and is zero mostly.
[Claim 4] The aforementioned voltage source is a micro motor according to claim 1 which impresses AC excitation voltage to some electrodes of the aforementioned electrode at least.
[Claim 5] The aforementioned electrode is a micro motor according to claim 1 which consists of two or more electrodes on the front face of each piezo-electric plate, and at least one electrode on the rear face of each piezo-electric plate.
[Claim 6] It is the micro motor according to claim 5 to which two or more aforementioned electrodes consist of an electrode in the 4-minute each round part of the front face of the above, and the aforementioned voltage source impresses AC excitation voltage to some electrodes on the front face of the above at least.
[Claim 7] The electrode of the quadrant section located on the diagonal line of each plate is a micro motor according to claim 5 to which the same polar excitation voltage is impressed.
[Claim 8] the [the 1st straight side edge of the 1st piezo-electricity plate, and] -- the excitation voltage of the 1st polarity impresses the electrode of the quadrant section between 1 short hand edges -- having -- the [the 1st straight side edge of the 2nd piezo-electricity plate, and] -- the micro motor according to claim 5 to which the voltage of the 2nd polarity with the electrode of the quadrant section between 1 short hand edges opposite to the 1st polarity is impressed
[Claim 9] the 1st and the 2nd page -- this -- the micro motor which consists of a power source which impresses the pulse excitation voltage which consists of an AC excitation voltage pulse which separated DC voltage which has a bigger absolute value than the amplitude of AC excitation voltage at least in some electrodes at the fixed interval with the piezo-electric plate of the rectangle which has the electrode attached in the 1st and the 2nd page
[Claim 10] The rate of a pulse of the aforementioned pulse excitation voltage is a micro motor according to claim 9 which carries out considerable to an objective self-resonant frequency mostly.
[Claim 11] the [the above 1st and] -- the micro motor according to claim 1 by which 2 rectangle piezo-electricity plate was connected to at least one longitudinal edge and to which it has the electrode of at least one addition, and a voltage source impresses some additional electrodes at least
[Claim 12] the above -- even if few -- one additional electrode -- the -- the micro motor according to claim 11 which consists of an electrode with the 1st straight side edge near the 1 short hand edge
[Claim 13] the above -- even if few -- one additional electrode -- the -- the micro motor according to claim 12 which consists of an electrode in the 2nd straight side edge near the 2 short hand edge
[Claim 14] The aforementioned voltage source is a micro motor according to claim 11 which impresses excitation voltage to an additional electrode and increases movement of the ceramic spacer in a direction

almost perpendicular to the aforementioned field by this.
[Claim 15] the [the above 1st and] -- 2 rectangle piezo-electricity plate -- the -- the micro motor according to claim 8 which impresses the 2nd excitation voltage of the above to the additional electrode of the 2nd plate while it has the additional electrode attached in the 1st straight side edge near the 1 short hand edge and the aforementioned voltage source impresses the 1st excitation voltage of the above to the additional electrode of the 1st plate
[Claim 16] the [the above 1st and] -- the micro motor of the claim 1 by which a movement amplitude with 2 piezo-electricity plate perpendicular to the aforementioned field is supported elastically the point on the plate which is zero mostly
[Claim 17] The aforementioned source of an elastic force is the micro motor of the claim 1 which can be adjusted.
[Claim 18] It is the micro motor of the claim 1 to which it becomes from two or more aforementioned 1st piezo-electricity plates and two or more aforementioned 2nd piezo-electricity plates, and the ceramic spacer of each plate is pressing the body elastically.
[Claim 19] The micro motor according to claim 1 which contains further the reverse means for supporting which engage with the front face of the aforementioned body opposite to the front face which engages with the aforementioned spacer in order to give the reaction force to the force impressed to a body by the spacer.
[Claim 20] The aforementioned reverse means for supporting are micro motors according to claim 19 to which it consists of piezo-electric ceramic bearing which has the electrode attached in at least one flat field, and the aforementioned voltage source impresses voltage to some piezo-electric ceramic bearings at least.
[Claim 21] the [the 1st and the 2nd page, two longitudinal edges and two short hand edges, and] -- with the rectangle piezo-electricity plate which has the ceramic spacer which is attached in 1 short hand edge and pressed by the body the [of a spacer support edge and an opposite side] -- with the source of an elastic force which impresses the force to 2 short hand edge It is the micro motor which consists of a power source which excites some aforementioned electrodes at least, and moves the body with which the aforementioned wavelength is equivalent to the wavelength of a spacer [as opposed to / the length of a spacer is equal to the integral multiple of the half-wave length, and / the frequency of the resonance mode of a request of a piezo-electric plate].
[Claim 22] The means micro motor which consists of at least one rectangle piezo-electricity plate which has the electrode attached in straight side and a short hand edge, the 1st and the 2nd page, the 1st page, and the 2nd page, a power supply which impresses the voltage of some electrodes at least and establishes the resonance mode of a request of a piezo-electric plate, and a mode suppression means to suppress resonance modes other than a desired resonance mode and which moves a body.
[Claim 23] The aforementioned mode suppression means is a micro motor according to claim 22 which consists of at least one suppression means which suited so that the dimensional change caused by resonance modes other than a desired resonance mode might be suppressed.
[Claim 24] It is the micro motor which is characterized by providing the following and which consists of an arm and moves the body which has the adjoining parallel field which suited so that the 1st and 2nd spacers might be energized to a body. At least one rectangle piezo-electricity plate which has two longitudinal edges and two short hand edges, the 1st, and the 2nd page. the [of a piezo-electric plate] -- the 1st ceramic spacer which is attached in the center of 1 short hand edge, and is pressed by the body the 2nd spacer attached in the end -- having -- the [of a piezo-electric plate] -- the other end in which 2 short hand edge was attached
[Claim 25] it consists of two longitudinal edges and two short hand edges, the 1st, and the 2nd page, and the aforementioned field is mutual-alike, it is parallel, and counters and the aforementioned longitudinal edge consists of an parallel contiguity plate -- being certain -- it separated mutually -- at least -- the [the 1st and] -- with 2 rectangle piezo-electricity plate To at least one which engages with the 2nd straight side edge of at least one fixed support which engages with the 1st straight side edge of the 1st plate of the above, and the 1st plate, an elastic support, At least one elastic support which engages with the 1st straight side edge of the 2nd plate of the above, And it is the micro motor by which it consists of at least one fixed support which engages with the 2nd straight side edge of the 2nd plate, and the 1st straight side edge of the 1st plate adjoins the 1st straight side edge of the 2nd plate.
[Claim 26] Each aforementioned support engages with each aforementioned piezo-electric plate at the moving point of zero mostly in the direction parallel to a short hand edge along with each longitudinal edge, and each support is the micro motor according to claim 25 which can be slid in the direction parallel to the aforementioned longitudinal edge.
[Claim 27] The micro motor which consists of a rectangle piezo-electricity plate which has straight side and a short hand edge, the 1st, and the 2nd page, and two or more elastic components [in / the direction

where a short hand edge is parallel / along with a longitudinal edge] which impress an elastic force to the aforementioned piezo-electric plate in respect of the dimensional change of zero mostly.

[Claim 28] It is the disk drive by which it can circle to the circumference of the piezo-electric plate which has the spacer attached in one of two longitudinal edges and two short hand edges, and the longitudinal edges of these, and a shaft, and consists of an arm which has the read-write head attached in the fixed interval remote 1st and the 2nd edge, and the 1st edge from the shaft concerned on both sides, and the rigid body in the 2nd edge, and the spacer of the aforementioned piezo-electric plate be elastically energized by the aforementioned rigid element

[Claim 29] The aforementioned piezo-electric plate is a stationary disk drive according to claim 28.

[Claim 30] The aforementioned piezo-electric plate is the disk drive according to claim 28 which can move to the aforementioned shaft.

[Claim 31] It is the disk drive which it consists of an arm which can circle to the circumference of a shaft, and this arm is attached in the read-write head and the 2nd edge which were attached in the fixed interval remote 1st and the 2nd edge, and the 1st edge from the shaft concerned on both sides, and has the piezo-electric plate which can move with the aforementioned arm.

[Claim 32] It is the disk drive which it consists of an arm which can circle to the circumference of a shaft, and this arm has the read-write head attached in the 1st and the 2nd edge, and the 1st edge, and the piezo-electric plate attached in the 2nd edge, and the aforementioned shaft penetrates the aforementioned piezo-electric plate, and is prolonged.

[Claim 33] It is the disk drive which consists of a rigid element which the arm which can circle to the circumference of a shaft, and this arm had the read-write head attached in the 1st and the 2nd edge, and the 1st edge, and the piezo-electric plate attached in the 2nd edge, the aforementioned shaft penetrated the aforementioned piezo-electric plate, was prolonged, and was energized to the aforementioned piezo-electric plate.

[Claim 34] It is the micro motor which can circle around a shaft, consists of a 2nd rectangle piezo-electricity plate which has the 1st rectangle piezo-electricity plate which has two longitudinal edges and two short hand edges, and the ceramic spacer attached in two longitudinal edges and two short hand edges, and this edge, and moves the body with which the aforementioned spacer is energized to the edge of the aforementioned 1st piezo-electricity plate.

[Claim 35] The aforementioned spacer is a micro motor according to claim 34 energized to the longitudinal edge of the aforementioned 1st piezo-electricity plate.

[Claim 36] It is a micro motor given in the sex 34 with which it becomes from the rigid segment element located between the longitudinal edges of the aforementioned spacer and the aforementioned 1st piezo-electricity plate, and this segment element connects movement of the aforementioned spacer, and movement of the aforementioned 1st piezo-electricity plate.

[Claim 37] the 3rd piezo-electricity plate which can circle around a shaft -- further -- containing -- this -- the spacer with which the 3rd piezo-electric plate was attached in the edge -- having -- this -- the micro motor according to claim 34 by which the spacer of the 3rd piezo-electric plate is energized to the edge and the edge of the piezo-electric plate of the above 1st of an opposite side by which the spacer of the aforementioned 2nd piezo-electricity plate is energized

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention -- a micro motor -- it is related with a piezoelectric motor in detail

[0002]

[Description of the Prior Art] Use of the resonance piezo-electricity ceramic which gives a straight line and rotation is well-known. The big advantage of such a system is in the capacity to attain very good movement, without using a movable machine part. Generally, such a system is restricted to the movement precision of 50 nanometers by open loop operation in 1 micrometer and closed-loop operation. When the weight of the plate which should be moved is 0.5kg, speed is restricted to 5-10 mm/sec. The force applied to a plate in the movement direction under such a situation is restricted to about 5 Ns. It is useful in many situations to attain bigger driving force than better solution, i.e., a quicker speed, to such a motor. This improved solution will become useful especially, when the capacity to exercise comparatively at high speed is held.

[0003]

[Problem(s) to be Solved by the Invention] SU693493 is indicating the piezoelectric motor which serves as 切切ate. An electrode on the back is grounded and the electrode on the diagonal line is connected electrically. Two ceramic pads are attached in one side between two edges of the longitudinal direction of a plate, and these pads are pressed by the driven body according to the spring mechanism which presses the edge of the longitudinal direction of another side.

[0004] While was connected, if AC voltage is impressed to one pair of electrodes, a body will move to one side, and if impressed by one pair of voltage of another side, the longitudinal direction and the direction of a short hand have the adjoining (as opposed to different mode instructions) resonance frequency so that a body may move to another side.

[0005] The purpose of this invention is to offer the micro motor which has a speed higher than a micro motor, conventional high driving force, and the conventional smaller minimum step size.

[0006]

[Means for Solving the Problem] The 1st feature of this invention consists of a piezo-electric ceramic of a thin rectangle which has two or more electrodes in the big field of one of these in at least one electrode and the big field of another side. Preferably, the single spacer of hard material is attached in the center of the short hand edge of a piezo-electric ceramic, and is pressed to the body. If some electrodes are energized at least, movement of either a piezo-electric ceramic or a body will arise along the length direction of the edge of a piezo-electric ceramic so that it may explain below.

[0007] It is desirable to be chosen in the 1st example of the feature of this invention, so that it may have the resonance arranged by approaching to x and y (size of the field where the rectangle of a piezo-electric ceramic is big) although the size of the field where a rectangle is big was the mode with which piezo-electric ceramics differed. Preferably, resonance has the duplicate response curve.

[0008] Excitation of a piezo-electric ceramic is the frequency by which both the modes are excited to what was chosen among two or more electrodes, and is attained by impressing AC voltage. In this example, when a small variation rate is required and a bigger variation rate is required during some minimum periods at least, resonance excitation is impressed during a longer period.

[0009] In the 2nd example of the feature of this invention, excitation is a pulse voltage for [to some] un-[dissonance] among two or more electrodes. this invention person found out that very small movement was attained, when the rectangular pulse which has high time comparatively higher than such a pulse, for example, low time, was used. Such excitation is useful especially when an electrode is expected for residual voltage not to remain after movement.

[0010] In the 3rd example of the feature of this invention, when a small step is required as the resonance

AC excitation to a comparatively big step, it is preferably switched between rectangular pulse excitation.
[0011] Many electrode configurations are possible by this invention. In the one example, two or more electrodes consist of two rectangle electrodes, and each electrode covers the half on one front face of a rectangle of a piezo-electric ceramic, and exists along with the longitudinal direction of the large rectangle side of a ceramic.
[0012] The 2nd desirable electrode configuration gives the electrode of four wraps for the four quadrant sections of the big field of a piezo-electric ceramic. When the ********** big minimum step size arises [rather than] to movement produced by the motor with different excitation mode (AC and pulse) and a different excitation configuration, one, two, or 3 of these electrodes are excited.
[0013] Although other features of this invention include the use of a piezo-electric ceramic of the plurality which has the same resonance frequency by which the laminating was carried out, it is more substantially [as for it, forming by different piezoelectric material is desirable, among those / one / than others] soft. The ceramic which has a different degree of hardness is separated from it and driven from a phasing signal on the same frequency. The force is small, although stiff material gives high driving force more in such a system between the portions of the cycle which drives a body and a softer material gives longer contact time. While permitting that a high start drive conquers inertia and static frictional force with this combination, it is accompanied by smooth operation during movement.
[0014] The desirable example of this invention includes use of the mode restraint which increases the efficiency of a micro motor by suppressing resonance modes other than the desired mode.
[0015] According to the feature of further others of this invention, the end of an arm is attached in the short hand edge of the piezo-electric ceramic of the opposite side of a spacer bearing edge. The spacer energized to the body is attached in the 2nd edge of an arm. Working, two spacers are similar, excite, and they separate from phase movement with a driven body, the output of a micro motor increases, and smooth movement of the body energized to the spacer is given by using movement and the force of the ends of a piezo-electric ceramic.
[0016] Other features of this invention are the points perpendicular to a longitudinal edge which have movement of zero mostly, and include use of the elastic component which impresses an elastic force to the longitudinal edge of a piezo-electric plate. Such an element is used for giving symmetrical movement to a body in both directions parallel to the short hand edge of a piezo-electric plate.
[0017] According to the feature of further others of this invention, the piezo-electric micro motor by this invention is used for movement of the optics of a disk drive, or a magnetic reading / writing head.
[0018] Therefore, the micro motor which moves a body in the desirable example of this invention The electrode attached in a longitudinal edge and a short hand edge, the 1st and the 2nd page, the 1st, and the 2nd page, the 1st edge -- with at least one rectangle piezo-electricity plate which has preferably the ceramic spacer of a short hand edge which is preferably attached in the center and is pressed by the body The force is preferably impressed to the 1st edge and the 2nd edge of an opposite side in the center, and it consists of a source of an elastic force which presses a ceramic spacer on a body, and a power source which excites some aforementioned electrodes at least.
[0019] In the desirable example of this invention, a voltage source energizes some electrodes with symmetrical unipolar pulse excitation voltage at least.
[0020] Preferably, a voltage source is a symmetrical unipolar pulse or either of the AC excitation, and it operates so that some electrodes may be impressed alternatively.
[0021] The electrode consists of at least one electrode in two or more electrodes of the 1st field of a piezo-electric plate which are in a round part 4 minute each preferably, and the 2nd field in the desirable example of this invention.
[0022] In the desirable example of this invention, the unipolar symmetrical pulse voltage in which the electrode which is in the quadrant section along with one longitudinal edge of the 1st field of a plate has the 1st polarity is impressed, and the unipolar symmetrical pulse voltage which has polarity with the opposite electrode which is in the quadrant section along with the longitudinal edge of another side of the 1st field is impressed.
[0023] The unipolar symmetrical pulse voltage which has polarity with the opposite electrode of each quadrant section which the unipolar symmetrical pulse voltage which has polarity with the opposite electrode of each quadrant section close to the ceramic spacer was impressed as an alternative plan, or is separated from a ceramic spacer is impressed.
[0024] In the desirable example of this invention, the unipolar symmetrical pulse voltage which has polarity predetermined in the electrode of the 1st group of the quadrant section located on the diagonal line is impressed, and the unipolar symmetrical pulse voltage which has polarity with the electrode of the 2nd group of the quadrant section located on the diagonal line opposite to the aforementioned predetermined polarity is impressed preferably.

[0025] In the desirable example of this invention, a micro motor consists of two or more aforementioned piezo-electric plates, and the ceramic spacer of each plate is elastically pressed by the body. Preferably, at least one of two or more of the plates is formed comparatively more by stiff piezoelectric material, and at least one of two or more of the plates is formed by comparatively more soft piezoelectric material. In the still more desirable example of this invention, a voltage source separates from a phase to each other, and impresses voltage to at least one of two or more of the plates.
[0026] In the desirable example of this invention, furthermore, straight side and a short hand edge, the 1st, and the 2nd page, At least one rectangle piezo-electricity plate with which it has the electrode attached in the 1st page and the 2nd page, and some electrodes of this electrode are impressed with symmetrical and unipolar pulse excitation voltage at least, the source of an elastic force which energizes elastically the extension of the edge beyond one edge, 1, or it to a body -- a shell -- the micro motor which moves a body is offered
[0027] Furthermore, at least one rectangle piezo-electricity plate which has the electrode attached in straight side and a short hand edge, the 1st and the 2nd page, the 1st page, and the 2nd page in the desirable example of this invention, The source of an elastic force which energizes elastically the extension of the edge beyond one edge, 1, or it to a body, the voltage source which impresses alternatively unipolar pulse excitation voltage or unipolar AC excitation voltage symmetrical with some electrodes at least -- a shell -- the micro motor which moves a body is offered
[0028] In the desirable example of this invention, it has the electrode attached in straight side and a short hand edge, the 1st and the 2nd page, the 1st page, and the 2nd page. Furthermore, two or more rectangle piezo-electricity plates of this electrode with which some are excited at least, the source of an elastic force which energizes elastically the extension of the edge beyond one edge of two or more of these plates, 1, or it to a body -- a shell -- the micro motor which moves a body is offered
[0029] In the desirable example of this invention, furthermore, straight side and a short hand edge, the 1st, and the 2nd page, Have the electrode attached in the 1st page and the 2nd page, and at least one of the electrodes of these is excited on voltage. Cause the force only toward one edge of a plate and at least one of the electrodes of other is excited on voltage. at least one rectangle piezo-electricity plate which causes movement of a part of at least edge which has the element which has met the aforementioned edge -- a shell -- the micro motor which moves a body is offered
[0030] Furthermore, at least one rectangle piezo-electricity plate which has the electrode attached in straight side and a short hand edge, the 1st and the 2nd page, the 1st page, and the 2nd page in the desirable example of this invention, the power supply which impresses the voltage of some electrodes at least and establishes the resonance mode of a request of a piezo-electric plate, and a mode suppression means to suppress resonance modes other than a desired resonance mode -- a shell -- the micro motor which moves a body is offered
[0031] The aforementioned mode suppression means consists of at least one suppression means which suited so that the dimensional change caused by resonance modes other than a desired resonance mode might be suppressed in the desirable example of this invention.
[0032] Furthermore, at least one rectangle piezo-electricity plate which has two longitudinal edges and two short hand edges, the 1st, and the 2nd page in the desirable example of this invention, the [of a piezo-electric plate] -- with the 1st ceramic spacer which is attached in the center of 1 short hand edge, and is pressed by the body It consists of an arm which has the other end in which 2 short hand edge was attached. the 2nd spacer attached in the end -- having -- the [of a piezo-electric plate] -- The micro motor which has the adjoining parallel field which suited so that the 1st and 2nd spacers might be energized to a body and which moves a body is offered.
[0033] In the desirable example of this invention, furthermore, straight side and a short hand edge, the 1st, and the 2nd page, Two or more rectangle piezo-electricity plates which have the electrode attached in the 1st page and the 2nd page, and have the hole of this electrode which some were excited at least and prepared at the fixed interval in accordance with the central longitudinal shaft, at least one lever which has the end with which a hole is equipped possible [rotation] -- a shell -- the micro motor which moves a body is offered
[0034] Preferably, the plate restrained so that a fixed plate might be equipped possible [rotation] or it might move only to the aforementioned shaft orientation as the alternative plan is equipped with the other end of a lever possible [rotation].
[0035] It is desirable that a ceramic spacer is preferably attached in the center of the short hand edge in all the above examples one of the short hand edges of a piezo-electric plate. Since the optimal drive movement is produced with the short hand edge of a ceramic plate by this, the space in which use perpendicular to an engagement side is possible becomes almost perpendicular [the longitudinal edge of - TO] to an engagement side. According to the desirable example of this invention, the ceramic micro motor

of an alternative plan is prepared in the system to which an available field perpendicular to an engagement side is restricted. Here, movement of the short hand edge of a piezo-electric ceramic plate is used for moving the longitudinal edge of a plate, and the installed body using the spacer attached in the longitudinal edge of a plate near the corner section of a longitudinal edge and a short edge.

[0036] According to this feature of this invention, although a spacer runs by the short hand edge according to resonance movement, an engagement side is driven in parallel with the longitudinal shaft of a ceramic plate. In order to avoid the symmetric property of right-and-left movement, it is desirable to use with a spacer two piezo-electric ceramic plates arranged in parallel in support of the corner section which adjoins each other.

[0037] furthermore -- the desirable example of this invention -- the [the 1st and] -- the [2 straight-side edge, the 1st, and] -- the [the 1st which has 2 short hand edge, a front face, and a rear face, and] -- with 2 rectangle piezo-electricity plate It is mostly installed in parallel side by side, and each plate has the electrode of 1 short hand edge attached in the front face and the rear face. the [of the 1st plate] -- 1 short hand edge -- the [of the 2nd plate **] -- each plate the -- it being attached in the 1st straight side edge by the end near the 1 short hand edge, and it having the ceramic spacer engaged on the surface of a body, being impressed by some each plate, and with the source of an elastic force which presses a ceramic spacer on the surface of a body a shell -- the piezo-electric micro motor which gives movement to a body is offered

[0038] In the desirable example of this invention, the aforementioned source of an elastic force is impressed to a part of 2nd straight side edge at least. , as an alternative plan, the aforementioned source of an elastic force is impressed to the point on a piezo-electric plate, and a movement amplitude perpendicular to the aforementioned field is zero mostly.

[0039] furthermore, in the desirable example of this invention, it was mutual-alike, it separated and has been arranged -- almost -- the [of a rectangle / the 1st and] -- with 2 piezo-electricity plate Each plate has two longitudinal edges and two short hand edges, a front face, and a rear face. At least one fixed support which the field of an adjoining plate is parallel, is parallel as for the longitudinal edge of the plate which counters and adjoins each other, and engages with the 1st straight side edge of the 1st plate, At least one elastic support which engages with the 2nd straight side edge of the 1st plate, At least one elastic support which engages with the 1st straight side edge of the 2nd plate, It consists of at least one fixed support which engages with the 2nd straight side edge of the 2nd plate, and the piezo-electric micro motor by which the 1st straight side edge of the 1st plate adjoins the 1st straight side edge of the 2nd plate and which gives movement to a body is offered.

[0040] Preferably, each support is the point which serves as movement of zero mostly in the direction perpendicular to a longitudinal edge, can engage with each longitudinal edge, and can be slid in the direction almost parallel to a longitudinal edge.

[0041] In the desirable example of this invention, furthermore, straight side and a short hand edge, the 1st, and the 2nd page, a direction perpendicular to the electrode and the longitudinal edge which were attached in the 1st page and the 2nd page -- almost -- movement of zero -- ** -- with at least one rectangle piezo-electricity plate which has the elastic component which gives an elastic force to each of a longitudinal edge at two becoming points The 1st mode in which movement is given in the 1st parallel, the two modes, i.e., a short hand edge, direction for some electrodes by the short hand at least, the power supply for exciting alternatively in the 2nd mode in which movement is given in the 2nd direction opposite to the 1st direction -- a shell -- the means micro motor which moves a body is offered

[0042] A micro motor consists of a structure assembly which suited so that movement and the force still more symmetrical with the 1st direction and 2nd direction might be given in other desirable examples of this invention. Preferably, a structure assembly contains an elastic component.

[0043] In the desirable example of this invention, the aforementioned voltage source impresses AC excitation voltage to some electrodes of the aforementioned electrode at least.

[0044] Furthermore, the aforementioned electrode consists of two or more electrodes on the front face of each piezo-electric plate, and at least one electrode on the rear face of each piezo-electric plate in the desirable example. Preferably, two or more aforementioned electrodes consist of an electrode in the 4-minute each round part of the front face of the above, and the aforementioned voltage source impresses AC excitation voltage to some electrodes on the front face of the above at least.

[0045] In the desirable example of this invention, polar excitation voltage with the same electrode of the quadrant section located on the diagonal line of each plate is impressed.

[0046] furthermore -- a desirable example -- the [the 1st straight side edge of the 1st piezo-electricity plate, and] -- the excitation voltage of the 1st polarity impresses the electrode of the quadrant section between 1 short hand edges -- having -- the [the 1st straight side edge of the 2nd piezo-electricity plate, and] -- the voltage of the 2nd polarity with the electrode of the quadrant section between 1 short hand

edges opposite to the 1st polarity is impressed
[0047] In the one desirable example of this invention, a power source impresses at least the pulse excitation voltage which consists of an AC excitation voltage pulse which separated DC voltage which has a bigger absolute value than the amplitude of AC excitation voltage at the fixed interval to some electrodes. Preferably, the pulse rate of the aforementioned pulse excitation voltage is mostly equivalent to an objective self-resonant frequency.
[0048] the still more desirable example of this invention -- the [the above 1st and] -- 2 rectangle piezo-electricity plate has the electrode of at least one addition connected to at least one longitudinal edge, and a voltage source impresses some additional electrodes at least desirable -- the above -- even if few -- one additional electrode -- the -- an electrode with the 1st straight side edge near the 1 short hand edge is included further -- desirable -- the above -- even if few -- one additional electrode -- the -- the electrode in the 2nd straight side edge near the 2 short hand edge is included
[0049] Preferably, the aforementioned voltage source impresses excitation voltage to an additional electrode, and, thereby, increases movement of the ceramic spacer in a direction almost perpendicular to the aforementioned field. Preferably, the aforementioned voltage source impresses the same polar excitation voltage as the electrode in the quadrant section of the front face which adjoins an additional electrode to each additional electrode.
[0050] the desirable example of this invention -- the [the above 1st and] -- 2 piezo-electricity plate is supported elastically . the point on the plate whose movement amplitude perpendicular to the aforementioned field is zero mostly
[0051] The aforementioned source of an elastic force can be adjusted in the desirable example of this invention.
[0052] In the desirable example of this invention, a micro motor consists of two or more aforementioned 1st piezo-electricity plates and two or more aforementioned 2nd piezo-electricity plates, and the ceramic spacer of each plate is pressing the body elastically.
[0053] In the desirable example of this invention, a micro motor contains further the reverse means for supporting which engage with the front face of the aforementioned body opposite to the front face which engages with the aforementioned spacer, in order to give further the reaction force to the force impressed to a body by the spacer. Preferably, the aforementioned reverse means for supporting consist of piezo-electric ceramic bearing which has the electrode attached in at least one flat field, and the aforementioned voltage source impresses voltage to some piezo-electric ceramic bearings at least.
[0054] furthermore, the arm which has the read-write head which could circle to the circumference of a shaft and was attached in the fixed interval remote 1st and the 2nd edge, and the 1st edge from the shaft concerned on both sides in the desirable example of this invention, and the rigid body in the 2nd edge and at least one piezo-electric plate micro motor elastically energized to the rigid-body element -- since -- the becoming disk drive is offered
[0055] In the desirable example of this invention, the aforementioned piezo-electric plate is standing it still. In the desirable example used as the alternative plan of this invention, the aforementioned piezo-electric plate is movable to the aforementioned shaft.
[0056] Furthermore, in the desirable example of this invention, it consists of an arm which can circle to the circumference of a shaft, and this arm is attached in the read-write head and the 2nd edge which were attached in the fixed interval remote 1st and the 2nd edge, and the 1st edge from the shaft concerned on both sides, and the disk drive which has the piezo-electric plate which can move with the aforementioned arm is offered.
[0057] In the desirable example of this invention, the aforementioned shaft penetrated the aforementioned piezo-electric plate, and is prolonged.
[0058] In the desirable example of this invention, a micro motor consists of a rigid element energized to the aforementioned piezo-electric plate further.
[0059] Furthermore, the 1st rectangle piezo-electricity plate which can circle around a shaft and has two longitudinal edges and two short hand edges in the desirable example of this invention, It consists of a 2nd rectangle piezo-electricity plate which has the ceramic spacer attached in two longitudinal edges and two short hand edges, and this edge, and the micro motor by which the aforementioned spacer is energized to the edge of the aforementioned 1st piezo-electricity plate and which moves a body is offered.
[0060] Preferably, the spacer attached in the aforementioned 2nd piezo-electricity plate is energized to the longitudinal edge of the aforementioned 1st piezo-electricity plate.
[0061] A micro motor consists of a rigid segment element further located between the longitudinal edges of the 1st piezo-electricity plate with which the spacer and the aforementioned spacer of the aforementioned 2nd piezo-electricity plate are energized in some the desirable examples of this invention.
[0062]

[Example] Drawing 1 which shows one field where the piezo-electric ceramic of the comparatively thin rectangle used in the motor by the desirable example of this invention is big is referred to. in the field (henceforth "the 1st page") of this piezo-electric ceramic, four electrodes 14, 16, 18, and 20 are galvanized -- **** (plated) -- ****** is stuck as if and, thereby, the checkered pattern with which each consists 1/4 of the 1st page of a wrap rectangle substantially is formed The field (henceforth "the 2nd page") of the opposite side of a piezo-electric ceramic is desirable, and the whole is substantially covered by one electrode (not shown). The electrode (20; 14, and 16 and 18) arranged in the direction of the diagonal line is electrically connected by the wires 22 and 24 preferably arranged near the joining segment (junction) of the four electrode. The electrode on the 2nd page is grounded preferably. Instead, you may connect these electrodes with printed circuit technology similar to the technology used for the formation.

[0063] The spacer 26 of a comparatively hard ceramic is preferably attached in the shorter side 28 of the piezo-electric ceramic 10 in the center of the side with cement.

[0064] The piezo-electric ceramic 10 has many resonance modes (resonaces). The resonance mode of Dx and the Dy direction is approaching (closely spaced), and, especially as for the size of the piezo-electric ceramic 10, a size with which an excitation curve (excitation curves) laps is chosen. Especially the desirable resonance by this invention is 1 / 2 mode resonance about the Dy direction, and is 11 / 2 mode resonance about the Dx direction as shown in drawing 2 and drawing 4 . However, other resonance modes can be used according to the size of a ceramic 10.

[0065] When excited on the frequency in the band where the piezo-electric ceramic 10 was shown as omega 0 in drawing 6 , the resonance mode of the both sides of Dx and Dy is excited. Drawing 3 impresses voltage to a predetermined electrode, and shows an example (one configuration) which excites two resonance modes by that cause. in this example, voltage is impressed to electrodes 16 and 18, and electrodes 14 and 20 have floated -- it is (or although it is not so desirable, grounded) -- the amplitude in the mode is shown in drawing 2 When the excitation in this example makes Dx negative when Dy is positive, consequently the movement of the piezo-electric ceramic 10 is prevented, the main part 30 pushed against the piezo-electric ceramic 10 will move leftward. Although the front face of a main part 30 is drawn as curved like the front face of the cylinder which should rotate, when a straightline travel is desired, flatness is sufficient as the front face.

[0066] Although the mode of Dy is the same about the example of excitation shown in drawing 5 in which voltage is impressed to electrodes 14 and 20, and electrodes 16 and 18 have floated (or grounded although it is not so desirable), the mode of Dx has a reverse phase and produces movement rightward.

[0067] Movement is prevented in the desirable example of this invention by one pair of base materials 32 and 34 to which the piezo-electric ceramic 10 was fixed, and the base materials (spring loaded supports) 36 and 38 with two springs. As for base materials 32-38, movement of x directions is in contact with the piezo-electric ceramic 10 along one pair of long sides 40 and 42 of the ceramic in the position of 0. These base materials are designed so that it may slide in the direction of y.

[0068] Thus, the spring is attached for reducing the effect (effect of wear) of wear and protecting a piezo-electric ceramic from a shock a certain grade (a degree of shock protection).

[0069] The base material 44 with a spring is preferably forced on the center section of the 2nd shorter side 43 of the piezo-electric ceramic 10 of the opposite side of a shorter side 28. A base material 44 gives a pressure between a ceramic 26 and a main part 30, and, thereby, the movement of a ceramic 26 is transmitted to a main part 30. It should be cautious of the base material 44 with a spring having the response time longer enough than one period of the frequency by which the piezo-electric ceramic 10 is excited. Therefore, while the ceramic 26 is moving the direction of movement and the contrary which are given to a main part 30, as for the front face of the ceramic 26 forced on the main part 30, only some periods of the period separate from the main part in fact.

[0070] In the desirable example of this invention, the base materials 36, 38, and 44 with a spring are hard pillar objects made of rubber (spring) with which contents were got blocked, and are desirable things made of silicone rubber which have the degree of hardness (a Shore A hardness of about 60) of Shore A of about 60 preferably. Such a "spring" can actually be manufactured by cutting a part of O ring (for example, thing with which the commercial scene is provided with the parka-honey fin (Parker-Hannifin)), and making it desired size. Preferably, the resonance mode of the spring should be distantly separated from the resonance mode of the piezo-electric ceramic used. In the desirable example of this invention, spherical or hard semi-sphere-like parts (element) are arranged between the spring parts (spring element) and ceramic.

[0071] In the desirable example of this invention, the size of the piezo-electric ceramic 10 is a 30mmx7.7mm size which has the thickness between 2mm and 5mm, when the PZT piezoelectric material manufactured by Morgan MATOROKKU (Morgan Matroc Inc.) is used. To this example, according to a desired speed, the weight (and/or, pressure of a spring 44) of a main part 30, and the force (power)

demanded, in order to excite the piezo-electric ceramic 10, a 30-500-volt alternating current can be used. Such equipment is 20-100kHz. It operates on frequency within the limits, has the minimum step size (a minimum stepsize) of 10 nanometers (nm) within the limits, and has the maximum velocity of about 15 to 350 mm/sec (or more than it). It does not pass over these in the range of nominal, but they change according to the material used as a piezo-electric ceramic 10, a size, the resonance mode chosen, and other factors.

[0072] The ceramic of an actual more large size can be made into for 20mm and 80mm, and the thing of a smaller size can be made into for 3mm and 20mm. For example, thin, very long equipment (for example, 3mmx80mm) will serve as a very high-speed motor.

[0073] By using the spacer 26 attached in the shorter side 28 of the piezo-electric ceramic 10 energized to a main part 30, the force which comes out of the micro motor of the given size increases compared with the micro motor of the same size in which the spacer is not attached. When the spacer is not attached, a shorter side 28 acts on the direct main part 30 (engage). Increase of this force is the result of being because the energy of the resonance mode generated within a piezo-electric ceramic during excitation concentrating on a spacer.

[0074] Preferably, a spacer 26 should not affect the resonance mode of a system. Moreover, it is desirable to attain a possible peak swing about movement of x directions to a given energy output (power output). These targets may be attained by using an extremely thin spacer. However, since the spacer made thin from the point of resonance frequency is often too thin, it is not practical at all. The more practical solution by the desirable example of this invention is using the spacer of length almost equal to 2/2 of the resonance mode in the spacer, 3/2, or 4/2 wave. A spacer 26 is manufactured by 99% of aluminum. 1/2 wave of the resonance mode of a spacer is about 3 times as short as 1/2 wave in the ceramic of the same frequency because of the difference of material with the aforementioned ceramic and this spacer (about 1/is the length of 3). It has become clear that the spacer made from a ceramic which has a length of about 4-5mm is suitable in fact.

[0075] In the example which related with drawing 1 - drawing 6 , and was explained above, the piezo-electric ceramic 10 in drawing 1 is excited by the alternating voltage of the frequency near resonance of the piezo-electric ceramic. It is excited by polar pulse-like single voltage (a pulsed unipolar voltage) by the method drawn on drawing 7 and 8. In the example of excitation of the shape of this pulse by this invention, it does not necessarily connect by the fixed method [as / in the example of drawing 1], and electrodes 14, 16, 18, and 20 are connected by different method according to the minimum step demanded so that it may explain below.

[0076] The principle of operation of the method by the pulse is shown in drawing 7 . In this drawing, on the basis of the electrode on the 2nd page of the piezo-electric ceramic 10, electrodes 14 and 18 are excited by positive direct current voltage, and electrodes 16 and 20 are excited by negative direct current voltage. Under this excitation, the left-hand side 10 of the piezo-electric ceramic 10 becomes longer than right-hand side (in drawing 7 , it is exaggerated very much and drawn), and a ceramic 26 moves rightward. Though natural, if voltage is no longer impressed, this ceramic will return to the original position.

[0077] However, if an unsymmetrical voltage pulse, for example, a voltage pulse as shown in drawing 8 , is impressed to an electrode, while returning to zero, the invention-in-this-application person has found out that a main part does not return to the start position by the ceramic 26. You should make it the falling time of this pulse become at least 4 times as long as build up time preferably. Although it is desirable that it is ten to 50 millisecond as for the time (a total pulse time) of the whole pulse, it depends for exact time on the force of the mass and the spring 44 which are moved by the piezo-electric ceramic. The outstanding result is obtained by 1-microsecond build up time and the falling time of 15 milliseconds in the experiment. The minimum step of this example may change to 2-6nm to the peak voltage of 30-100 volts depending on a pulse voltage, and since inertia increases to larger mass, the minimum step becomes large. Generally, although this mode is not used for big movement, it is useful to arrangement of the culmination of the object to which it is made to move. When polarity of excitation is made reverse, or build up time is lengthened, it falls and time is shortened, it will move in the opposite direction. Although operation of the main part in this mode is not necessarily understood well, it can realize the extremely small minimum step.

[0078] or [that the electrode pair of another side grounds by impressing voltage only to one electrode pair (electrified) instead of the above] -- or it is made to float

[0079] In the substitute example in which a motor operates in the shape of a pulse, the voltage same to electrodes 14 and 16 is impressed, and opposite polar voltage is impressed to electrodes 18 and 20 (or it is grounded or keeps floated). Very small movement will be performed by such voltage impression (electrification).

[0080] Another minimum step value is acquired by other examples which excite an electrode with the voltage of the shape of such a pulse. For example, if an electrode 14 is excited by the positive pulse and an electrode 16 is excited by the negative pulse (it is supposed on the other hand that it is grounded or electrodes 18 and 20 have been floated), the about 2-5nm minimum step will be obtained. By exciting electrodes 18 and 20 by the positive and negative pulse, respectively (electrodes 14 and 16 presupposing preferably that it has floated on the other hand), the 5-8nm minimum step is obtained. When one polar pulse is impressed to electrodes 14 and 18 and the opposite polar pulse is impressed to an electrode 20, (the electrode's 16 having floated) and the minimum step of the same value are obtained. Although the electrode it was presupposed that had been floated in the above as a substitute example can be grounded, efficiency will fall in this case.

[0081] Especially, while a positive pulse is impressed to two electrodes 14 and 20 in useful differential mode, two electrodes 16 and 18 are grounded, and are changed into a float state, or a negative pulse is impressed. In this mode, the minimum, very small movement can be attained 0.1 or in 2nm. You may impress the same or a different pulse of the voltage of an amplitude to the electrode of the direction of a vertical angle.

[0082] The excitation by the pulse voltage is useful again, when have the configuration preferably illustrated by drawing 8 , and it is used, for example, each electrode is separated and it is impressed by the configuration of conventional technology like the configuration of SU No. 693494 mentioned above which can be excited.

[0083] In the desirable example of the motor concerning this invention, the piezo-electric ceramic 10 is excited by a certain alternating voltage as explained with reference to drawing 1 or drawing 6 , and, subsequently is excited by pulse voltage which was mentioned above with reference to drawing 7 and drawing 8 so that high-speed movement may be first generated near the target position. One desirable example of the motor system containing the equipment configuration for such excitation is illustrated in the form of the block diagram in drawing 9 .

[0084] As shown in drawing 9 , C-system 50 is equipped with the controller which is the microcontroller 52 which controls impressing energy to one pair of regulator power supplies 54 and 56 by which voltage regulation was carried out, respectively, and the four a switch/modulator circuits 58, 60, 62, and 64. Each of a switch/modulator circuit is connected to electrodes 14, 16, and 18 or one of the 20. The electrode on the 2nd field is preferably grounded through the inductor 66 for alignment.

[0085] A microcontroller 52 receives the position signal from a position indicator (or position transducer) 68 which shows the position of the body 30 and offers feedback to a microcontroller 52 preferably. Preferably, a microcontroller 52 receives a position (or movement), is still more optional and receives the speed command from a user interface 70 again.

[0086] Setting working, a microcontroller 52 receives the position command from a user interface 70, and compares with the actual position to which it is directed by the position indicator 68. If a command is a move command, the position will merely be memorized for a next comparison (record).

[0087] A microcontroller 52 memorizes the amount of movement needed and determines whether alternating current mode or a pulse mode is suitable and which direction the direction to which almost all the bodies move is based on the optimization criteria decided beforehand. Two or more suitable signals are outputted to a switch/modulator circuit so that the piezo-electric ceramic 10 may operate in an excitation configuration suitable as mentioned above, and those signals may generate either alternating voltage or a pulse voltage (or non-voltage or grounding voltage) and may be impressed to each electrode. The distance which remains in the distance which should move decreases below on suitable level, and a microcontroller 52 is switched to the high resolution low speed mode mentioned above with reference to drawing 7 and drawing 8 in which suitable pulse excitation is used. When asking for accuracy with a high position, you may perform some deformation in an excitation format suitably. When the body 30 arrives at a target position, excitation of two or more electrodes is ended.

[0088] An inductor 66 is used in order to align with the same frequency as mechanical resonance of the piezo-electric ceramic 10 the wiring connected to electric resonance and electric it of the piezo-electric ceramic 10. It is appropriate for an electrical circuit to add an inductor like an inductor 66, in order to set up this electrostatic capacity out of "alignment and to improve the efficiency of "and the system concerned, since it consists of most electrostatic capacity formed of two or more electrodes on the 1st of the piezo-electric ceramic 10 and the 2nd field.

[0089] Although control of the movement of the system concerned has explained the closed-loop system, open loop operation by lower correctness is also possible. To closed-loop operation, it is believed that the system concerned can attain good correctness rather than about 0.5nm. To open loop operation, evaluation detection of the amount of movement can be carried out considerably at accuracy, and a position can be controlled within about 0.1% of the amount of the whole movement, and 1%.

[0090] According to the desirable example of this invention, in order to make the capacity of a micro motor increase by suppressing resonance modes other than a desired resonance mode, at least one restricted member (constraining menber) is used. Drawing 32 shows the form for which two restricted members were used, and drawing 33 shows a certain form like drawing 32 which shows the ceramic 10 about the request mode which emphasized and showed the blank from an actual size. the attached restraint with which the profile of the piezo-electric ceramic 10 was equipped strongly -- a member 300,302 can be created with thread or a wire, and can be pasted up on the above-mentioned piezo-electric ceramic Moreover, a member 300.302 can also include plastics or metal forming. A member 300.302 is preferably located in the position of the about 1/6 and the simultaneouslies 5/6 of the point, i.e., the length of a ceramic 10, that a dimensional change is 0, in the direction of X about request mode of operation. In other modes, it has a dimensional change in both those both [1 or], and is suppressed by it. In such a form, it can be increased by the movement width of face (motion amplitude) of a spacer 26 by reaching to 30% as compared with the movement width of face obtained in the same input power in the micro motor which does not have a restricted member. Moreover, the restricted member of either a sign 300 or the sign 302 is used.

[0091] In the desirable example of this invention, as shown in drawing 34 , in order to make smooth operation of the main part which increases the output of the above-mentioned micro motor and is pressed by the above-mentioned spacer, a fixed arm 310 is attached in the short circuit edge (short edge) of the piezo-electric ceramic 10 to a spacer bearing edge (bearing edge). An arm 310 is preferably attached mostly in the front face of the piezo-electric ceramic 10 at parallel, and the end of an arm 310 is attached in the short circuit edge 43 of a ceramic 10 through the vertical section material 314. The spacer 312 which is pressed by the main part 30 and attached is attached in the other end of an arm 310 near [in which a spacer 26 is attached] the edge of a ceramic 10.

[0092] Many of other desirable forms of the example of drawing 34 exist. In one of such the forms, a spacer 312 is a ceramic preferably and the vertical section material 314 is preferably created with aluminum. In this form, in order to avoid that the vertical section material 314 short-circuits the electrode of the 1st page of the piezo-electric ceramic 10, you have to take special cautions. In other forms, the vertical section material 314 is a ceramic. In the form mentioned above, the vertical section material 314 can be attached along the whole short circuit edge 43, or can be attached only in the center section of the short circuit edge 43 for example, with a ceramic spacer.

[0093] In a form as shown in drawing 3 or drawing 5 , one use of the form mentioned above in relation to excitation (excitation) of the piezo-electric ceramic 10 by AC voltage serves as out of phase operation (difference of the phase of 180 degrees) of a spacer 312 about a spacer 26, as shown in drawing 35 . As a result, the force committed on a main part 30 becomes double precision, and the movement of a main part 30 becomes more smooth compared with the micro motor which does not use such an arm.

[0094] Moreover, other excitation (excitations) and the form of an element 10 can be used in relation to the equipment shown in drawing 35 from drawing 32 so that it may describe here. In the desirable example of the motor by this invention, it can form since two or more piezo-electric ceramics increase the output of the above-mentioned motor, and in order to reduce change (variability) which exists between different equipment. Such one form shown in drawing 10 is equipped with two piezo-electric ceramics 10 and 10' with a tandem-type form. namely, the piezo-electric ceramic 10 and the direction of operation induced by 10' -- setting -- two piezo-electric ceramics 10 and 10' -- a calyx is carried out and it is attached in a form Two piezo-electric ceramics can be driven with a common control system like the control system 50 shown in drawing 9 , or the separated control system. A control system and electrical installation are not shown in drawing 10 so that it may become clear.

[0095] As shown in drawing 10 , the piezo-electric ceramic 10 and the spacer unit 74 located in the middle of 10' support the above-mentioned piezo-electric ceramic, and dissociates. Four spring energization side supports 76, two spring energization, and support 78 support a piezo-electric ceramic pair by the same method which was mentioned above in relation to the example of drawing 1 . In fact, it is restrained that the piezo-electric ceramic 10 and 10' move at right angles to the front face of a piezo-electric ceramic by the elongation of the spacer unit 74 and the spring energization supports 76 and 78 preferably. Such a form is shown in drawing 11 .

[0096] Drawing 11 shows six piezo-electric ceramics formed with the tandem type / parallel form of two units and three units. Although the mechanism of the press spacer unit 74 to a spring energization support and a piezo-electric ceramic is not shown for restrictions of illustration, the desirable support mechanism is shown in drawing 10. moreover, they are other forms -- it goes away 2x4 and a form / parallel form is also useful

[0097] In the desirable example of the motor by this invention, not all the piezo-electric ceramics used for the example shown in drawing 10 and drawing 11 are the same. In this example of this invention, it is

comparatively created with stiff material and one or two or more piezo-electric ceramics are created with a soft material [like PZT-8 (manufactured in Morgan Matroc Inc.)] like PZT-5H (manufactured in Morgan Matroc Inc.) whose one or two or more piezo-electric ceramics are. The material of the two above-mentioned types has the same resonance (resonance) as the x [same] and y size, and it can form it physically so that it may be obtained, when resonance frequency adjusts the thickness of each piezo-electric ceramic. Moreover, both material can also use it by the same thickness. In such a form, BURODA (broader) Q of the above-mentioned soft material will assume that both stiff material and soft material are fully excited on the same frequency (excite).

[0098] the above -- when a soft piezo-electric ceramic is charged, resonance width of face becomes large in both Dx and Dy, and the portion (time) of the period when a ceramic 26 contacts a main part becomes [rather than] large about the above-mentioned stiff piezo-electricity ceramic However, with this property, the amount of motive power on which a soft piezo-electric ceramic acts becomes low, and unevenness of operation also becomes low.

[0099] As the previous paragraph described, in the desirable example of this invention for which the piezo-electric ceramic of both types is used, a stiff piezo-electricity ceramic has the capacity to stop static friction and other inertia forces, and a soft piezo-electric ceramic has the more smooth capacity which gives more exact operation by a halt more smooth than the case where only a stiff piezo-electricity ceramic is used, and starting.

[0100] In the desirable example of this invention, the ceramic of two types starts an out of phase (phase contrast of 180 degrees) mutually. In this case, the ceramic of two types operates by the method which essentially became independent (in portion from which an excitation cycle (excitation cycle) differs), and serves as friction of the minimum for operation from which the piezo-electric ceramic of two types differs. In the desirable example of this invention, the inversion of a phase is attained by using the ceramic which made the polarization direction reverse with two ceramics. Moreover, the voltage which carried out the out of phase can also be impressed. Opposite phase operation of the above-mentioned ceramic is useful again, when two piezo-electric ceramics of the same property are used.

[0101] X-Y movement which has all the advantageous points of this invention is also possible. One gestalt which produces X-Y movement is shown in drawing 12 . Before X configuration section 90 of an integral is formed with a piezo-electric ceramic material and formed in the flat big inside of the above-mentioned section, it has a back electrode. The single electrode arranged on the whole surface is prepared in the above-mentioned (and the field shown completely partially is received) inside which is not illustrated. Those single electrodes are grounded (or it connects with system power common return), and according to the desirable example of this invention, the above-mentioned electrode shown is activated according to the mechanism mentioned above. Constituting an X-Y table from such a device holds the above-mentioned ceramic, as mentioned above according to drawing 1 and drawing 11 , and it is only required that the flat table in contact with a ceramic 26 should be added. said -- two or more X configuration sections 90 of 1 or a different ceramic are usable in a parallel-tandem-type gestalt which was mentioned above about drawing 10 and drawing 11

[0102] drawing 13 is obtained to the 2nd ** to visualize, and the gestalt which is not small is shown briefly, and this structure fixes to one so that two piezo-electric ceramics as shown in drawing 1 -5 may attain X movement by the end, and Y movement by the other end

[0103] X-Y table 100 which used the gestalt of drawing 13 and was constituted as a desirable example of the invention in this application is illustrated in the form simplified by drawing 14 . A table 100 consists of two piezo-electric ceramics 10 into the gestalt of drawing 13 inserted between the fixed base 102 and the top 104, and base materials 106 and 108,110,112,114, and 116,118 and 120 are the same in a form and a function to the base materials 32, 34, 36, and 38 of drawing 1 -5. It is not attached in the base 102 although all the base materials 106-120 are formed in the fixing object (not displayed clearly) at one. However, it is desirable that the slider allowed to carry out slide movement of between a fixing object and the bases 102 in the direction of X (for an arrow 122 to show) is prepared, and it is attached in the fixing object.

[0104] The sliders 124,126 and 128 of a lot are formed so that operation of the top 104 may be allowed in the direction of Y shown by the arrow 130 about a fixing object. As for sliders 124-128, being attached in a fixing object is desirable.

[0105] In short, the fixing object has the up-and-down piezo-electric ceramic 10 and the up-and-down base material for sliders, and the aforementioned slider allows slide movement of the top 104 in the direction of X in the direction of Y to a fixing object and this fixing object to the base 102.

[0106] Excitation of the piezo-electric ceramic under use and by the side of a lower part moves it in the direction of X. Since the top 104 is regulated [moving in the direction of X to a fixing object, and] by the aforementioned fixing object, only the same amount moves the top 104 in the direction of X like a fixing

object. Therefore, excitation of the piezo-electric ceramic by the side of a lower part produces X movement of the top 104. When the piezo-electric ceramic by the side of the upper part is excited, the top 104 moves in the direction of Y to a fixing object. Since the fixing object is regulated so that it may move in the direction of Y partly to the base, the top 104 moves to the base 102. .

[0107] Exciting alternatively the piezo-electric ceramic of the upper part and a lower part produces X-Y operation of the top 104 to the base 102, and it has all the advantages of the example about the rectilinear motion shown about the example of drawing 1 - drawing 11 in the top. On the other hand, excitation of only one of the piezo-electric ceramics produces movement of only **.

[0108] It is possible to use the principle sketched in X, Y, Z movement, X and Y, theta movement, or the movement direction in alignment with two or more shafts which are not right-angled, and a ceramic which is different in order to make it exercise in accordance with each shaft may be prepared.

[0109] Furthermore, the two-piece column of a piezo-electric ceramic and in-series arrangement which consist of the same parts or it differs produce the same use as the above-mentioned like the two-piece column arrangement about rectilinear-motion equipment by referring to drawing 10 and drawing 11 .

[0110] As use of the piezo-electric ceramic concerning the invention in this application being shown in drawing 15 , in order to attain rotation, and having been shown by drawing 10 , the same two-piece column gestalt of the piezo-electric ceramic 150 is applied so that a cylinder 152 may be met, and so that a cylinder 152 may be rotated. It is desirable to have the concave surface configuration to which the front face of the ceramic spacer 26 meets the front face of a cylinder 152 according to such a gestalt. Some of same single piezo-electricity ceramics or piezo-electric ceramics which have been arranged annularly can be used also instead of a gestalt 150 with having been shown in drawing 1 -5.

[0111] When the spherical circular motion and 3-dimensional positioning are required, a gestalt like drawing 15 is used like a gestalt 150 from preparing three ceramic constituents arranged so that it may intersect perpendicularly, correcting, in order to rotate and position a sphere. When only rotation is required (and 3-dimensional positioning is not required), two mechanical components which intersect perpendicularly are enough. In this example, it is formed so that the outside surface of a ceramic 26 may meet a spherical front face.

[0112] When using the invention in this application, it is possible for speed, accuracy, and driving force to combine and to improve. Since a ceramic is pushed to a main part 30 more than the advanced technology for cracking for which the excessive force is needed by using only the single ceramic pad 26, the bigger force can be used. Use of the ceramic of a two-piece column brings about increase of driving force and speed unexpectedly. both a general more high speed and bigger driving force -- although -- at the invention in this application, it can attain simultaneously with the piezo-electric ceramic of the same volume

[0113] Moreover, when the electrode of the shape of a rectangle illustrated in the above-mentioned example is used, movement is not a perfect straight line, namely, as for the invention in this application, it turns out for the rotation property of movement of a ceramic 26 that a part of ceramic contacts the working main part 30. When 14', 16', 18', and 20' are the electrodes which have not carried out just the straight-line-ized version shown in the above-mentioned drawing, it can improve by cutting an electrode, as shown in drawing 16 . [0114] which can be improved so that equipment may straight-line-ize other electrode configurations although sine change is shown in drawing 16 The arrangement which an example is given to drawing 36 and contains two or more piezo-electric ceramics as a desirable example of this invention is used in order to consider movement of a main part 30 as symmetrical movement along with the X-axis at opposite direction. When this arrangement is used substantially, the same force and the same amplitude can be applied in X and the direction of -X. The arrangement shown by drawing 36 is

[0115] which has two parallel piezo-electric ceramics 10 oriented in the same direction at X shown by drawing 36 , and the X-Y flat surface formed of the direction of Y, and 10'. As shown in drawing 36 , as for each of the piezo-electric ceramic 10 and 10', movement is regulated with the fixed base materials 32 and 34 of a couple, and the elastic-support objects 36 and 38 of a couple. Base materials 32-38 tend to make a ceramic 10 and 10' movement magnitude zero along with a parenchyma top and the X-axis along with the corners 40 and 42 of the longitudinal direction of each ceramic and 40', and 42', and are paying well. As for base materials 32-38, it is desirable for it to be able to slide along with a Y-axis.

[0116] The fixed base materials 32 and 34 pay the piezo-electric ceramic 10 well along with the corner 40 of a longitudinal direction, and on the other hand, since piezo-electric ceramic 10' is being fixed, base materials 32 and 34 are paying well corner 42' of a longitudinal direction. The elastic-support objects 36 and 38 meet the corner 42 of a longitudinal direction, the piezo-electric ceramic 10 is paid well, and, on the other hand, the elastic-support object 36.38 is paying well piezo-electric ceramic 10' along with corner 40' of a longitudinal direction for piezo-electric ceramic 10'. Differences among some between X brought about by one piezo-electric ceramic by this arrangement and -X movement are compensated by other

same and opposite piezo-electric ceramics.
[0117] The alternative arrangement for offering symmetrical movement in alignment with the X-axis is illustrated by drawing 37 as a desirable example of this invention.
[0118] Drawing 37 shows two equipments which completely have the assemblies 320 and 340 of the same composition. An assembly 320 consists of the two rigid bodies 322 and 324, and the pedestal (not shown) is equipped with them by hinges 328 and 329, respectively while they are connected by the hinge 326. Similarly, the pedestal is equipped with the assembly 340 by hinges 327, 341, and 342, respectively.
[0119] Hinges 326 and 327 are prolonged in the hole, especially ceramic side of the piezo-electric ceramic 10. As for a hinge 326 and the hole for 327, it is desirable that it is the position which is arranged among electrodes 18 and 20 between two electrodes (for example, between electrodes 14 and 16) along a short edge, respectively, and does not operate along with the X-axis. Hinges 326 and 327 are distant from the short edge 28 with the desirable example of this invention, respectively by the length of 1/6 of a ceramic 10, and 5/6.
[0120] As for each element 322, it is desirable that have two arms 330 and 331 in the opposite side of a ceramic 10, and each element 324 has arms 334 and 335 in the opposite side of a ceramic 10. Thereby, a ceramic 10 is arranged between arms 330 and 331 and arms 334 and 335. As for elastic components 337 and 338, it is desirable between the arms 330 and 331 of an element 322 to be arranged among the arms 334 and 335 of an element 324. the elastic components 337 and 338 of an assembly 320 -- about [of the length of a ceramic] -- one sixth -- the piezo-electric ceramic 10 -- an elastic force -- giving -- **** -- the same element of ASEMBURO 340 -- about [of the length of a ceramic 10] -- an elastic force is given by five sixths
[0121] one typical equipment -- the piezo-electric ceramic 10 -- PZT- it is constituted by 4 and has a length of 300mm, width of face of 7mm, and the thickness of 3mm The elastic components 337 and 338 in this equipment are 5mm in length, and are the silicon cylinders of the diameter of 2.5-3mm, and Shore hardness 60-70. An elastic component 44 is 2.5mm in a length of 5mm, and diameter, and can exert about 5 Ns (Newton) force on the short edge 43 of the piezo-electric ceramic 10. it is shown in drawing 3 or drawing 5 -- as -- alternating current 200- the case where excite a piezo-electric ceramic by 300V, and this equipment is used -- a maximum of [the resolution (resolution) of 0.1-0.3 micrometers, and] -- the speed of about 400 mm/sec is obtained
[0122] In the desirable example of this invention, the electrode of the configuration shown in drawing 17 is used. In addition to electrodes 14, 16, 18, and 20, for the gestalt of this operation, the addition electrode 150 is applied to the piezo-electric ceramic. An electrode 150 is preferably installed to the same width of face as a ceramic 10, and is excited by the harmonic voltage used by direct current voltage or other electrodes. As a result of such excitation, it is elongated and a ceramic 10 gives a reserve load to a motor to a move object. By using harmonic excitation, this reserve load synchronizes to other electrodes, and increases the contact time between a ceramic 26 and a move object. Although a theory top can omit a spring 44 from such a system, some (it reacts further slowly rather than a piezo-electric ceramic) elastic energization force is used in fact, and there is even by the need. The same operation is obtained from drawing 18 and the example of 19.
[0123] Other wearing meanses applicable to both a simple substance and two or more ceramic motors are shown in drawing 20 . The hole is formed in the center of the piezo-electric ceramic 10, and one sixth on the center line and the position of 5/6 with this wearing means. As for these holes, it is desirable to have 20 and 30% of diameter of the thickness of a ceramic 10. a pin 152 -- about **100-micrometer crevice -- having -- a hole -- it is arranged inside and the end at least is attached in the end of levers 154, 156, and 158 The pin is formed with the material which has the same acoustic velocity as being transmitted within a ceramic 10. What is necessary is for a pin just to consist of a metal, a ceramic, or other suitable material.
[0124] For the resonance mode of the ceramic 10 used in the desirable example of this invention, a ceramic moves only in the direction of a major axis of a hole. actually -- a center -- a hole hardly moves If the other end of a lever is attached in the fixing main part 160 free [rotation], only by a ceramic's 10 meeting the major axis, it will be moved. This becomes possible to remove springs 36 and 38. Furthermore, a spring 44 promotes one of the levers in the direction to which a body is moved, and is replaced by spring 44' which energizes a motor. Many of such springs are used so that other levers may be energized.
[0125] The same principle is applied only to equipping with two installed piezo-electric ceramic elements 10 and 10', as shown in drawing 21 . In this arrangement, five levers 162, 164, 166, 168, and 170 used for an above-mentioned means are equipped with the piezo-electric ceramic 10 and 10'. A lever 170 should note being the lever of the single member which fixes at the center of a plate 172 while being preferably attached in the center of both ceramics. other levers can rotate an end to one hole of a ceramic -- it is equipped and is equipped with the other end by the plate 172 possible [rotation] Each ceramic 10 and 10' are separately energized with the spring 44 in the soffit.

[0126] With other gestalten, a ceramic 10 and 10' are not energized with a spring. However, the plate 172 is energized with the spring (not shown) by the soffit, in order to be only able to move only perpendicularly and to energize a ceramic 10 and 10' to a move object. Of course, a technical improvement is possible for the various width-of-face sizes of a wearing means by using the lever rule in these desirable examples.

[0127] The main advantages which equip an above-mentioned pin with a piezo-electric ceramic are reducing the temperature of a ceramic notably, and it is attained by taking heat from an attaching position. Moreover, an attaching position is also a hot portion with a desirable operation gestalt. Especially the temperature of these positions can be reduced by using this means from 50-80 degrees C to about 30 degrees C.

[0128] When heat conduction from a ceramic to a pin is good, the cooling effect of a pin is heightened. In order to ensure such heat conduction, thermal conductivity of a pin is good and it should be relatively fixed in a soft material, for example, the elastomer which covers the wall of a hole. It is used in an amount inadequate for one suitable material being epoxy and it hardening. A hole is enough for such a spring material to rotate a pin partially small. PZT powder is filled up with the desirable example of this invention into epoxy (the same material as the piezo-electric ceramic itself) about 40%. The acoustic velocity in epoxy can be doubled with a piezo-electric ceramic by such restoration.

[0129] Moreover, the movement of equipment has a measurable ceramic 26 based on the amount of time to be in a contact state to a move object. In order to make such measurement easy, the front face of a ceramic facing a move object is coated with a metal, and the electrode touches this coating. For this purpose, coating is extended to the flank of a ceramic 26. A move object consists of a metal (or thing which has metal coating), and can measure contact time as short circuit duration between metal coating and the move objects of a ceramic 26.

[0130] Drawing 22 , and 23 and 24 show the case where a ceramic motor is applied to the movement of a stage, and they are used as an optical disk reading machine like CD reading machine. With such equipment, a hole 164 is formed in a stage 160 and the optical reading machine (not alone shown) with which the stage 160 was equipped with the hole 164 detects an optical disk (and it reads).

[0131] In drawing 22 , two rails 162 and ceramic motors 166 are equipped with the stage 160. As for this ceramic motor, it is desirable that it is one of the types explained here, and in order to move a stage along with a rail, it is formed in one marginal part of a stage 160 possible [movement].

[0132] In drawing 23 and 24, the rail was equipped with one marginal part of a stage 160, and other marginal parts have geared to the worm 168 with the rack 170. As for the ceramic motor 172, it is desirable that it is one of the types explained here, and the wheel 174 with which the end of a worm was equipped is driven. The way, as for drawing 23 and 24, a motor drives a wheel is different.

[0133] In all the above-mentioned examples, the spacer between a ceramic plate and the front face in which a micro motor is attached is the short edge of a ceramic plate, while is preferably attached in the center of a short edge. The longitudinal direction of a plate is right-angled to a clamp face. Since optical drive operation is obtained on the short edge of a ceramic plate, this arrangement is desirable. However, in some examples of application, in case a motor is arranged between a slide and its housing, the usable space which intersects perpendicularly with a clamp face has a limit, and it becomes short rather than the longitudinal direction of a ceramic plate, for example. In order to solve this problem, this invention offers other ceramic micro motors. Although it has the parallel longitudinal direction of a ceramic plate to a clamp face, optical operation produced on the short edge of a ceramic plate can use.

[0134] About such a mode of this invention, a ceramic spacer is attached in the end of the longer edge of a piezo-electric plate, and is attached in the field parallel to a longer edge. Since the spacer attached such is arranged near the short edge of a ceramic plate, a spacer moves with regards to resonance operation on the short edge. Thus, the movement of the front face which engages with a spacer, or a micro motor is obtained as a result of movement of a spacer. The movement is dependent on both being restrained by the direction of a major axis of a ceramic plate, and parallel. However, arranging a spacer in an edge or its near rather produces the unsymmetrical movement of a spacer rather than the center section of the longer edge of a plate. Then, on the other hand, Mukai's clamp face differs from the movement of a micro motor, for example, it consists of congruous movement in other directions feebly or slowly. In order to abolish this asymmetry, as for a piezo-electric ceramic plate, it is desirable to use it by the couple so that it may mention later.

[0135] Drawing 15 which illustrates in graph the piezo-electric micro motor 200 which is attached in the front face 210, and which makes a pair is referred to now. In the example which does not make the pair mentioned above, the movement of either a front face 210 or the micro motor 200 is restrained, and makes other movement possible depending on the force impressed. A micro motor 200 is equipped with two piezo-electric ceramic plates 212 and 214 with which it was preferably equipped in the housing 220 which

becomes with aluminum. Housing 220 is preferably pushed to a front face 210. The short edge of the outside of plates 212 and 214, i.e., the right-hand side edge of a plate 212 and the left-hand side edge of a plate 214 illustrated by drawing 25 , is desirable, for example, it is supported by the horizontal supporter material 222 formed with comparatively hard material, such as ceramic material. the connection in which the short edge inside plates 212 and 214, i.e., the left-hand side edge of a plate 212, and the right-hand side edge of a plate 214 were preferably formed by hard rubber or hard plastic material and which is preferably elastic -- it is supported by the member 226 Plates 212 and 214 are supported from the pars basilaris ossis occipitalis by the pars-basilaris-ossis-occipitalis supporter material 224 which can be formed with the same material as a member 226, or a desirable more hard material.

[0136] According to the desirable example concerning this invention, the spacer 216 which becomes with a ceramic preferably is attached in the upper front face of a plate 212 in the left end section, and the same spacer 28 is attached in the upper front face of a plate 214 at the right end section. When a micro motor 200 is forced to a front face 210, spacers 212 and 214 fit in with a front face 210 functionally, and are attached. In the desirable example concerning this invention, it dissociates partially at least with the field of the front face 210 which it had preferably the frame 215 for the protection which was formed or was covered with low friction materials, such as Teflon, and the frame 215 concerned fitted in with spacers 216 and 218, and was attached, and a housing 220 prevents that that for which it does not ask [dust] is accumulated on a front face 210.

[0137] Four electrodes are plated so that the pattern electrode of the shape of the checkered board which has the shape of two or more rectangle may be formed, or it is attached in each front face of the piezo-electric ceramic plates 212 and 214, and if that is not right, each of two or more rectangles of a pattern electrode covers one fourth of front faces substantially here, as mentioned above with reference to the electrodes 14, 16, 18, and 20 in drawing 1 . As the rear face of each piezo-electric ceramic plate was mentioned above with reference to drawing 1 , the whole is substantially covered using one electrode (not shown). Two electrodes [as / in the example of drawing 1] located in the direction of a vertical angle are electrically connected by two or more wires 230 preferably placed near the joint of four electrodes. Two or more electrodes on the rear face of each ceramic plate are grounded preferably. Instead, two or more electrodes are connectable with the print printed wiring technology used in order to form two or more above-mentioned electrodes, and the same technology.

[0138] Two or more electrodes on a plate 212 and 214 are preferably driven by the excitation circuit illustrated in the form of the block diagram in drawing 25 . The excitation circuit concerned is equipped with the controller which is the microcontroller 244 which controls impression of the energy to the regulator power supply 242 by which voltage adjustment was carried out, and the switch/modulator circuit 240. Two or more switches which can be set to a switch / modulator circuit 240 are connected to the electrode of each group as which it was beforehand chosen on the front face of plates 212 and 214 through equivalents, such as wires 234 and 236 or an electrode pattern of the printed wiring. Two or more electrodes on the rear face of the ceramic plates 212 and 214 are preferably grounded through a tuning circuit equipped with amplifier 246 and a coil 248.

[0139] Apart from the special excitation mode mentioned later, according to the arbitrary modes mentioned above with reference to the example which does not make the pair of this invention, it may connect mutually and two or more electrodes on each ceramic plate 212 and 214 may be excited so that the micro motor 200 which has the feature for which it asked according to the given application may be offered. Similarly, you may form the ceramic spacers 214 and 216 with comparatively frail or comparatively hard ceramics like an above-mentioned example. However, in order to obtain the movement of spacers 216 and 218 in the same horizontal direction to a front face 210 so that it may mention later, it is necessary to reverse excitation of two or more electrodes on a plate 212 as compared with excitation of two or more electrodes on a plate 214.

[0140] Drawing 26 which illustrates two or more desirable x-y resonance modes in the piezo-electric ceramic plates 212 and 214, and illustrates an outline simply [a part of micro motor 200] is referred to now again. Two or more electrodes on a plate 212 and 214 are preferably divided into the electrode 254 and electrode 256 which are an electrode of two groups so that drawing 26 may be set and it may be illustrated. When the excitation voltage impressed to an electrode 254 generally has the polarity impressed to an electrode 256, and opposite polarity, namely, negative voltage is impressed to the electrode 256, positive voltage is impressed to an electrode 254, and voltage is impressed them and reversely.

[0141] While a spacer 216 is attached in the left-hand side edge of a plate 212, a spacer 218 is attached in the right-hand side edge of a plate 214, and it should recognize that the excitation method in drawing 26 brings about the movement of the spacers 216 and 218 of the same direction in alignment with the X-axis, i.e., a longitudinal direction, when the two above-mentioned spacers move in the same direction in

alignment with the Y-axis, i.e., the vertical direction. Therefore, always, spacers 216 and 218 move in the same direction to a front face 210 so that it may be wanted. According to this excitation method, the graph-graph of the resonance mode of X and Y of the piezo-electric ceramics 212 and 214 is illustrated by the plate 212 and 214 bottom in graph. The pars-basilaris-ossis-occipitalis supporter material 224 is preferably formed in two or more plate 212 and point bottom on 214, and the movement which the Y-axis met, i.e., deltay, becomes zero substantially here so that it may be further illustrated in drawing 26 . This improves the stability of a micro motor 200 and maximizes the amplitude obtained by the micro motor 200 along with the y-axis.

[0142] Drawing 27 which illustrates in graph the excitation signal of the shape of a pulse form controlled by the microcontroller 244 (drawing 25) with which the electrodes 254 and 256 concerning one desirable example of this invention are provided is referred to now. The excitation signal of drawing 27 consists of two or more pulses of the drive excitation voltage separated with the interval of the direct current voltage decided beforehand operated so that two or more spacers may be moved without contacting a front face 210. In drawing 27 , the difference of the voltage between the top peak of excitation voltage and the bottom peak of excitation voltage is shown by "A", and the direct current voltage between pulses is shown by "B." According to this example of a suitable this invention, the pulse rate of an excitation signal is substantially set up according to the self-resonant frequency of the body attached by the micro motor to the micro motor which does not make the pair mentioned above.

[0143] Generally two or more typical resonance frequency of two or more bodies driven by the micro motor, i.e., two or more frequency in 300Hz order, is very lower than the number of drive ac cycles used, and each pulse contains the actual number in the period of the alternating current to drive. Generally, the direct current voltage B impressed to the electrodes 254 and 256 (refer to drawing 25 .) between pulses is lower than the peak by the side of the low of drive frequency depending on which shall drive between an electrode 254 or 256, or higher than the peak of a side with high drive frequency so that spacers 216 and 218 may separate from a front face 210 between pulses. Therefore, the body to drive moves between pulses autonomously. This interrelation between the pulse rate of the above-mentioned excitation signal and self-resonance of the body attached [above-mentioned] so that fitting might be carried out prevents the destructive interference between a driving pulse and the response of the body which answered it and was driven.

[0144] Drawing 28 which illustrates the ceramic plate 212 and the electrode configuration of the modification on 214 in graph is referred to now. According to this example concerning this invention, two or more additional electrodes 260 are formed on the top edge of plates 212 and 214, and a bottom edge. Two or more electrodes 260 are excited by two or more same excitation voltage used since two or more electrodes 256 (drawing 26) are driven preferably. In this configuration, the amplitude of the movement of the spacers 216 and 218 in alignment with the Y-axis should recognize that it is larger than the amplitude of the movement of two or more spacers in alignment with the X-axis so that it may be illustrated by the spacers 216 and 218 bottom in graph. This elliptical movement of spacers 216 and 218 that inclined a little in contrast with circular movement substantially [two or more spacers which can be set to drawing 26 illustrated in graph on two or more spacers] Since such movement increases the time of contact between spacers 216 and 218 and a front face 210, the micro motor 200 which has bigger driving force and better attraction (traction force) between two or more spacers and a front face 210 is offered.

[0145] Drawing 29 illustrating the wearing structure of the modification of the piezo-electric ceramic plates 212 and 214 is referred to now. the horizontal supporter material 222 and connection -- a member 226 -- in addition, it is supported by the base 266 where plates 212 and 214 are the plate 212 and plate 214 bottoms, and it was equipped with them in housing 220 (drawing 25) among them Two or more plates 212 and 214 are supported with two or more electrode holders 262 which have an elastic force preferably again. while being equipped with the end of each electrode holder 262 possible [rotation] on each mount (mounting) 265 preferably attached in housing 220 fixed, the other end of each electrode holder 262 can be set to a plate 212 or 214 -- each -- it is equipped possible [rotation] on each pin 264 which extends through a hole It is preferably equipped with four pins 264 on a plate 212 and 214, and is equipped with them in two or more points with which the amplitude to which two pins met on each plate at the Y-axis serves as zero substantially as mentioned above. In a desirable example, it is equipped with two electrode holders 262 on each pin 264, and each side of a plate 212 or 214 is equipped with one electrode holder. It is preferably equipped with the pars-basilaris-ossis-occipitalis supporter material 263 with elasticity between the bottom edge of each electrode holder 262, and the pars-basilaris-ossis-occipitalis edge of a plate 212 or a plate 214. Offer of two or more electrode holders 262 which support plates 212 and 214 in two or more positions optimal as mentioned above improves the stability of a micro motor 200. Preferably, two or more spacers 262 incline so that it may be illustrated by drawing 29 , and they make possible the piezo-electric plate 212 and movement of a drive of 214 along

with a Y-axis by this.
[0146] Drawing 30 illustrating the wearing structure of one modification where I accept it for plates 212 and 214 is referred to now. According to this structure, two or more pins 264 of drawing 29 and two or more same pins 268 are on a plate 212 and 214, and the position where the amplitude of movement becomes zero substantially is equipped with them as mentioned above. Therefore, according to two or more above-mentioned resonance modes, you may equip each plate with three pins 268. It is equipped with at least one spring 270 which is a desirable steel spring on two or more pins 268 by the method illustrated in drawing 30 . The edge of a spring 270 is connected with an adjusting screw in housing 220 so that it may be extended between two bobbins 272 with which it is preferably equipped with a spring 70 on the desirable horizontal supporter material 222. This stretching energizes the level support 222 to a way short hand edge outside plates 212 and 214 further, and offers the good support with the piezo-electric plate. Although the tension of a spring 70 can be adjusted using a screw 274, it controls the elasticity of plates 212 and 214 to movement in alignment with the y-axis. Thereby, contraction of a micro motor 200, speed, and the force are controllable.
[0147] Reference of drawing 31 illustrates the desirable arrangement for engaging a micro motor 200 with the comparatively thin body 278. If a micro motor engages with a thin body, the rhythm force (pulsed force) impressed to the body by the motor may damage a body slightly in an engagement field, or may make it generally crooked. For this reason, this invention person devised the counter bearing equipment 280 which makes this problem the minimum. As for the counter-bearing equipment 280 which is the desirable example of this invention, according to this, it is desirable to fix this housing to the housing 220 of a micro motor 200 through a connector 290 including housing 282, and to connect. At least one bearing 284 in housing 282 offers the rigid support of the rear face (namely, field which does not engage with a micro motor 200) of a body 278 to the force impressed to the front face of a body 278 by spacers 216 and 218. Bearing 284 may be what well-known bearing, for example, a metal cylinder.
[0148] In the desirable example of counter-bearing equipment 280, bearing 284 contains plates 212 and 214 and a similar piezo-electric ceramic especially. At this example, for a grounding electrode (un-illustrating), the field of another side of bearing 284 includes [as opposed to / a wrap's / substantially] one flat field of bearing 284 for two separation electrodes 286 and 288, and they are wraps about the half of the field. As electrodes 286 and 288 show drawing 31, it is arranged up and down, and if AC voltage is impressed as mentioned above, bearing 284 will vibrate by resonance frequency along with y-axis. If bearing 284 drives on y-axis frequency of plates 212 and 214, suitable direction, for example, upper part, spacers 216 and 218 descend gradually and a spacer carries out the upper part, the very effective counter-bearing to the force applied by the micro motor 200 will be offered. This example of this invention has the advantage that it is applicable also like the micro motor which is not an above-mentioned group, when suitable structural adjustment is carried out.
[0149] Although it indicated that a micro motor 200 contained only one plate 212 and one plate 214, he has to understand that deformation of the example of drawing 25 -31 which uses two or more groups of the piezo-electric plates 212 and 214 is also included in the range of this invention. In such a case, as for the group of a plate, being equipped in parallel with each other is desirable.
[0150] It is used for the disk drive to which the piezo-electric ceramic 10 moves and positions reading / writing head in some the desirable examples of this invention. Such a gestalt is shown in drawing 38 -41. Drawing 38 is the block diagram of the disk drive containing the piezo-electric micro motor to which reading / writing head is moved. A disk drive 350 holds the disk 352 which can rotate around a shaft 354, and the reading / writing assembly 360. Reading / writing assembly 360 contains the arm 370 which can circle around a shaft 372, and the piezo-electric ceramic 10 used for making it circle in an arm 370 around a shaft 372. Scanning of a disk 352 is attained by rotating a disk 352 around a shaft 354, while rotating an arm 370 around a shaft 372. Although reading and the writing of a disk 352 are attained through reading / writing head 374, the head may be what well-known head attached in arm 370 edge.
[0151] Drawing 39 is the detail drawing of reading / writing assembly 360. As shown in drawing 39 , although anythings of an above-mentioned form can be used for the piezo-electric ceramic 10, it is desirable to fix and equip the element with which the fixed base (un-illustrating) was equipped possible [a slide] through the through mountings (through mounts) 385 and 386. The piezo-electric ceramic 10 is elastically energized by the elastic component 44 to the rigid element 380 of an arm 370. As for an elastic component 44, it is desirable to be pressed to the fixed element in the fixed base (un-illustrating). If excited according to one of the above-mentioned excitation configurations, the spacer 26 energized to the rigid element 380 will move in any direction of x or -x direction by the piezo-electric ceramic 10 depending on a voltage impression state. By the relative motion between the spacers 26 and arms 370 through the rigid element 380, an arm 370 circles around a shaft 372. Consequently, reading / writing head 374 moves in the direction of either theta which touches the radius of a disk 352 mostly, or -theta.

[0152] Mountings 385 and 386 penetrated the hole of the piezo-electric ceramic 10, and have spread. As for this hole, it is desirable that about 1/is arranged [of the length of a ceramic 10] in accordance with the longitudinal shaft of a ceramic 10 at the point of 6 and 5/6 inter-electrode. At these points, the variation rate and dimensional change of the ceramic 10 along a x axis are zero substantially.
[0153] Drawing 40 and drawing 41 differ from drawing 39 in that the fixed base is equipped with the piezo-electric ceramic 10. As shown in drawing 40 , the fixed base can be equipped with the piezo-electric ceramic 10 with the fixing elements 390 and 391 of a couple. the fixing elements 390 and 391 -- about [of the length of a ceramic] -- it is desirable to engage with the piezo-electric ceramic 10 at the point of one sixth and 5/6 In the ceramic 10 concerned, while restraining movement perpendicular to the longitudinal shaft, the piezo-electric ceramic 10 may be located in the guide hole formed in elements 390 and 391 so that movement in alignment with the longitudinal shaft of a ceramic 10 may be possible.
[0154] As an alternative plan, as shown in drawing 41 , the fixed base can be equipped with the piezo-electric ceramic 10 with the elastic-support element 392. Support elasticity is determined by the rigidity of the material which constitutes the support element 392. the support element 392 is attached in the fixed base (un-illustrating) -- having -- the longitudinal shaft of a ceramic 10 -- meeting -- about [of the length of a ceramic] -- it is desirable to engage with a ceramic 10 at the point of one sixth and 5/6
[0155] In order to remove the dust which accumulated on the element 380, as for the edges 395 and 396 of the support element 392, engaging with the element 380 of an arm 370 is desirable. the salients 397 and 398 arranged preferably at the spacer opposite side of the element 380 between a spacer 26 and ends 395 and 396 -- respectively -- the angle of an arm 370 -- the range of a variation rate was limited and it has suppressed that dust is accumulated near the spacer 26
[0156] In a practical example, the ratio between the radius of gyration R1 of the point on the element 380 about a shaft 372 and the radius of gyration R2 of the point on reading / writing head 374 about a shaft 372 is the order of 1 to 3, or 1-5. therefore, the predetermined angle of reading / writing head 374 on a disk 352 -- a variation rate -- the straight line to Dtheta -- a variation rate -- the predetermined angle of a spacer 26 -- a variation rate -- the straight line to Dtheta -- it is 5 times as large as a variation rate from about 3
[0157] In the suitable example of this invention, in order to make the readout of a disk drive, and the capacity of writing increase, many piezo-electric ceramics are used. The shaft 400 is equipped with the example of arrangement shown in two parallel piezo-electric ceramics 10 and drawing 42 showing 10'. It can use in order to carry out a readout and writing to the opposite side of a disk single in order that this arrangement may perform the above readout and writing in one disk simultaneously simultaneous or alternatively. However, either one piezo-electric ceramic 10 or 10' is used for the readout and writing to a disk of the single side.
[0158] In the arrangement shown in drawing 42 , revolution of both arms 370 and 370' is attained about the piezo-electric ceramic 10 and the shaft 400 which penetrated the hole of 10' and was extended.
[0159] For each piezo-electric ceramic, as for the above-mentioned hole, it is desirable that you make it located between the electrodes which adjoin along each short edge 28, and only 6 has separated about 1/from the short edge 28 of each above of the length of a ceramic. It is fixed to the shaft 400 which can be rotated and the piezo-electric ceramic 10 and 10' can be moved according to the shaft 400 to rotate. On the other hand, the piezo-electric ceramic 10 and 10' can also be attached possible [rotation at the shaft 400 held fixed] among the maintenance elements 404 and 405 so that each can be moved independently. As for the above-mentioned maintenance elements 404 and 405, being attached in the fixed base (not shown) is desirable.
[0160] The piezo-electric ceramic 10 and 10' are attached in the head 374 of a readout/writing, and 374' by the connection element 408 and 408', respectively. an element 408 is in the state along the long edges 40 and 42, and it is desirable to grasp installation ** or the piezo-electric ceramic 10 to the piezo-electric ceramic 10 As for an element 408, it is desirable to engage with a piezo-electric ceramic at about 1 of length of ceramic/2 and the point which is distant from the edge 28 where only 6 is short about 5/. As for corresponding element 408', it is desirable to engage with piezo-electric ceramic 10' along with long edge 40' and 42' in respect of above-mentioned 1 / 2 ****** 5/6. Change of the ceramic 10 in x directions, a point without the movement of 10', or a size exists in the above 1/2 and the point of 5/6 about. As for the hard element 410, it is desirable to be preferably energized by a ceramic 10, the spacer 26 of 10', and 26' using an elastic component 411, respectively.
[0161] Let the ratio of the radius of gyration of the point on the element 410 about a shaft 400, and the radius of gyration of the point on the head 374 of the readout/writing about a shaft 400 be a range between 1 to 5 and 1 to 10 in actual arrangement as shown in drawing 42 . Consequently, movement of the given angle By Dtheta, movement on the straight line of the head 374 of the readout/writing on a disk 352 can be enlarged 10 times from 5 times rather than movement on the straight line of a spacer 26,

respectively.
[0162] The piezo-electric ceramic 10 and this system containing 10' operate by the closed loop mode, and in order to determine the position of a write-in head, they contain the disk drive truck controller (not shown).
[0163] In the suitable example of this invention, while raising rotationability, in order to make the move angle of the head of a readout/writing increase, many piezo-electric ceramics are used. Drawing 43 shows an example of such arrangement and three piezo-electric ceramics are used in this arrangement. Piezo-electric ceramic 10' of a couple and 10" are used so that the piezo-electric ceramic 10 may be rotated about the shaft 420 attached suitable for the fixed base (not shown). The spacer 26 attached in the piezo-electric ceramic 10 is energized by the edge 440 of an arm 370. The force which a spacer 26 exerts on the edge 440 of an arm 370 makes the rotation about the shaft 372 of an arm 370 and the head 374 of a readout/writing attached in this cause according to the movement of a spacer 26.
[0164] In the suitable example of this invention, as explained above with reference to drawing 39 , piezo-electric ceramic 10' and 10" can be attached in the base as for which fixation was carried out [above-mentioned] by the shaft attached in the element with which the fixed base (not shown) was equipped possible [a slide], while being fixed about a shaft 420. On the other hand, piezo-electric ceramic 10' and 10" can also be attached in the fixed base by the fixed element or other methods which were explained in this, as shown in drawing 40 . A shaft 420 is the center of the piezo-electric ceramic 10, penetrated the hole preferably located in the intersection field of four electrodes of a ceramic, and is extended. Spacer 26' attached in piezo-electric ceramic 10' is energized at the concave surface side of the stiff circular element 426. It is desirable that the convex of the above-mentioned element 426 is mostly attached [of the long edge 40 of the piezo-electric ceramic 10] in the center. Excitation of piezo-electric ceramic 10' moves spacer 26' in the direction of y, or the direction of -y according to the voltage impressed. The force which spacer 26' exerts on an element 426 makes movement of an element 426 cause according to the movement of spacer 26'.
[0165] The force which an element 426 exerts on the piezo-electric ceramic 10 makes rotation of the piezo-electric ceramic 10 to the direction of theta, or the direction of -theta cause. As the element 426 was explained above, in order to connect piezo-electric ceramic 10" movement [spacer 26"] and rotation of the piezo-electric ceramic 10, as for an element 426 and the same circular element 427, it is desirable to be energized by the long edge 42 of the piezo-electric ceramic 10. The piezo-electric ceramic 10 is rotated in the direction of -theta, or the direction of theta, respectively, and, for the hand of cut, spacer 26" [to the direction of y or the direction of -y] movement is the about same movement as spacer 26'. The direction guided by piezo-electric ceramic 10' with Dy is opposite direction. Moreover, the movement of a spacer 26 which guides straight-line movement of a main part in x directions or -x direction can be attained by direct excitation of the piezo-electric ceramic 10.
[0166] piezo-electricity -- a ceramic -- ten -- ten -- ' -- and -- ten -- " -- each -- piezo-electricity -- a ceramic -- ten -- ten -- ' -- and -- ten -- " -- respectively -- attaching -- having had -- a spacer -- 26 -- 26 -- ' -- and -- 26 -- " -- movement -- mutual -- being related -- making -- a sake -- electric -- connecting -- having -- **** -- a thing -- being desirable . The movement of the whole spacer 26 and the movement of the head 374 of a readout/writing produced as the result consist of superposition of the piezo-electric ceramic 10, 10', and the 10" movement that is alike, respectively and is therefore produced separately. In addition, if it is this contractor that this invention shows especially here and is not restricted to what was explained, he will just be going to be understood. rather -- the range of this invention -- the above -- only a claim is determined
[0167] If the equipment explained above in relation with the mode of electrification (electrification) which it was shown to drawing 43 and explained previously is used While being able to give the angle of the range expanded to the head 374 of a readout/writing, and linear movement compared with the disk drive which does not use such arrangement The performance in which the whole moving range is covered and the movement of the head of a readout/writing can be adjusted elaborately can be raised. The piezo-electric ceramic 10, 10', and 10" excitation can attain a broad change of the profile of the movement for the head 374 of a readout/writing.
[0168]
[Effect of the Invention] According to this invention, the micro motor which has a speed higher than a micro motor, conventional high driving force, and the conventional smaller minimum step size can be offered so that clearly from the above explanation.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The schematic diagram of a useful piezo-electric ceramic element is shown in the motor by the desirable example of this invention.
[Drawing 2] The 1st excitation gestalt of the element of (A) by the desirable example of ******** is shown.
[Drawing 3] The mode view of drawing 2 is shown.
[Drawing 4] The 1st excitation gestalt of the element of (A) by the desirable example of this invention is shown.
[Drawing 5] The mode view of drawing 4 is shown.
[Drawing 6] The response curve of two resonance modes of the element of drawing 1 by the desirable example of this invention arranged by approaching is shown.
[Drawing 7] The move state of the shape of a bimorph of a useful piezo-electric element is shown in the motor by the desirable example of this invention.
[Drawing 8] When impressed by the electrode of the element shown in drawing 3 , the voltage pulse which causes movement by which the body in contact with an element was controlled is shown.
[Drawing 9] It is the block diagram of the micro motor which attains controlled movement by the desirable example of this invention.
[Drawing 10] It is the perspective diagram of a tandem form piezo-electricity ceramic element useful on the motor by the desirable example of this invention.
[Drawing 11] It is the perspective diagram of a tandem / parallel form piezo-electricity ceramic element useful on the motor by the desirable example of this invention.
[Drawing 12] The perspective diagram of the piezo-electric ceramic element which suited x-y movement by the desirable example of ******** is shown.
[Drawing 13] The perspective diagram of two piezo-electric ceramic elements which suited x-y movement by the desirable example of this invention is shown.
[Drawing 14] It is the perspective diagram using the example of drawing 13 of a x-y table.
[Drawing 15] The use for rotating the cylinder or sphere of a piezo-electric ceramic element by the desirable example of this invention is shown.
[Drawing 16] The electrode configuration of others for piezo-electric ceramics by the desirable example of this invention is shown.
[Drawing 17] The electrode configuration of having been suitable for impressing the pulley loading force of a piezo-electric ceramic to the driven body by the desirable example of this invention is shown.
[Drawing 18] The electrode configuration of having been suitable for impressing the pulley loading force of a piezo-electric ceramic to the driven body by the desirable example of this invention is shown.
[Drawing 19] The electrode configuration of having been suitable for impressing the pulley loading force of a piezo-electric ceramic to the driven body by the desirable example of this invention is shown.
[Drawing 20] Other methods of equipping with the piezo-electric ceramic by the desirable example of this invention are shown.
[Drawing 21] Application of the wearing principle of drawing 20 for equipping with two piezo-electric ceramics by the desirable example of this invention is shown.
[Drawing 22] Other gestalten which use a ceramic motor for the stage of CD reader by the desirable example of this invention are shown.
[Drawing 23] Other gestalten which use a ceramic motor for the stage of CD reader by the desirable example of this invention are shown.
[Drawing 24] Other gestalten which use a ceramic motor for the stage of CD reader by the desirable example of this invention are shown.
[Drawing 25] It is the block diagram of the piezo-electric micro motor which is manufactured according to the still more desirable example of this invention, and operates.
[Drawing 26] It is the schematic diagram of the micro motor of drawing 25 showing the desirable x-y

resonance mode of the piezo-electric ceramic of a micro motor.
[Drawing 27] It is the schematic diagram of the pulse excitation signal which drives the piezo-electric ceramic of the micro motor of drawing 25 by the desirable example of 1 of this invention.
[Drawing 28] It is the schematic diagram of the piezo-electric micro motor driven with different x and different y excitation amplitude.
[Drawing 29] It is the schematic diagram of other wearing states of the ceramic plate of the piezo-electric micro motor of drawing 25 .
[Drawing 30] It is the schematic diagram of the wearing state of further others of the ceramic plate of the piezo-electric micro motor of drawing 25 .
[Drawing 31] It is the schematic diagram showing drawing 25 , 26, and the desirable state of connecting the micro motor of 28-30 with a body in operation.
[Drawing 32] The schematic diagram of the piezo-electric micro motor using the suppression member for suppressing the resonance mode by the desirable example of this invention which is not desired is shown.
[Drawing 33] The vibrational motion by which the micro motor of drawing 32 was exaggerated is shown.
[Drawing 34] In order to give the output and smoother movement by the desirable example of ******** which were increased, the schematic diagram of the piezo-electric micro motor using the rigid arm is shown.
[Drawing 35] The relative motion of two spacers preferably used by the micro motor of drawing 34 to the selected excitation state is shown quantitatively.
[Drawing 36] It is the schematic diagram of other micro motors which suited giving symmetrical movement parallel to the short hand edge of the piezo-electric ceramic by the desirable example of this invention.
[Drawing 37] It is the schematic diagram of the micro motor of others [****s / which suit giving symmetrical movement parallel to the short hand edge of the piezo-electric ceramic by the desirable example of this invention].
[Drawing 38] In order to move reading / writing head, the outline block diagram of the disk drive by the desirable example of this invention which uses a piezo-electric micro motor is shown.
[Drawing 39] It is the schematic diagram showing other gestalten of reading / writing arm of the disk drive of drawing 38 by the desirable example of this invention.
[Drawing 40] It is the schematic diagram showing other gestalten of reading / writing arm of the disk drive of drawing 38 by the desirable example of this invention.
[Drawing 41] It is the schematic diagram showing other gestalten of reading / writing arm of the disk drive of drawing 38 by the desirable example of this invention.
[Drawing 42] It is the schematic diagram of the dual disk drive by the desirable example of this invention.
[Drawing 43] While giving the rotation and the straight-line displacement range by the desirable example of this invention which were increased, it is the schematic diagram of three piezo-electric plate arrangement which suited so that good tuning of movement of reading / writing head might be enabled.
[Description of Notations]
10 [-- Spacer.] -- A piezo-electric plate, 14, 16, 18, 20 -- An electrode, 26

[Translation done.]